DECLARATION

In the matter of
U.S.Serial No. 10/816,125
in the name of Yasuaki YATAGAI,
Hitoshi MATSUMURA,
and Hiroaki SHICHI

I, the undersigned, Kazuteru SHIMURA, of Fujimoto Patent and Law Office, of Room 317, Sanno Grand Building, 14-2, Nagata-cho 2-chome, Chiyoda-ku, Tokyo, Japan, do solemnly and sincerely declare as follows:

1. That I am well acquainted with the English and Japanese languages and am competent to translate Japanese into English and vice versa.

2. That I have executed, with the best of my ability, a true and correct translation to the attached copy of the complete description, claims, drawings and abstract originally filed as Japanese Patent Application No. 2000-285417.

This 24th day of July, 2006

Kazuteru SHIMURA

(Translation)

JAPAN PATENT OFFICE

This is to certify that the annexed is a true copy of the following application as filed with this Office.

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Application Number:	Patent Application No. 2000-285417
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is:	JP2000-285417
Applicant(s):	SUZUKI MOTOR CORPORATION

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Commissioner,
Japan Patent Office Makoto NAKAJIMA (Seal)

Certificate No. P 2005-3104728

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[IPC]	B62M 27/02
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[Amount]	¥21,000

[List of Submitted Things]

[Name of Thing]	Specification	1
[Name of Thing]	Drawing(s)	1
[Name of Thing]	Abstract	1
[General Power of Attorney No.]	9907804	

[NAME OF DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION]

SNOWMOBILE FOUR-CYCLE ENGINE ARRANGEMENT

[SCOPE OF CLAIM FOR PATENT]

[CLAIM 1] A snowmobile four-cycle engine arrangement, characterized in that a snowmobile four-cycle engine has a cylinder head on the top thereof and is arranged in an engine compartment formed in the front body of a snowmobile with its crankshaft laid substantially parallel to the body width and its engine body inclined forwards with respect to the vehicle's direction of travel, and an intake path is arranged on the upper face of the inclined engine body; and

a heat exchanger for cooling the engine cooling water, engine oil or air to be supplied to the engine is arranged in a tunnel created inside the body frame for accommodating a track for driving.

[CLAIM 2]

The snowmobile four-cycle engine arrangement according to Claim 1, wherein the heat exchanger is disposed in front of the track, with respect to the vehicle's direction of travel, inside the tunnel.

[CLAIM 3]

The snowmobile four-cycle engine arrangement according to Claim 1 or 2, wherein an intercooler for cooling the air to be supplied to the engine is put into use as the heat

exchanger.

[CLAIM 4]

The snowmobile four-cycle engine arrangement according to Claim 1 or 2, wherein an oil cooler for cooling the engine oil is put into use as the heat exchanger.

[CLAIM 5]

The snowmobile four-cycle engine arrangement according to Claim 1 or 2, wherein a radiator for cooling the engine cooling water is put into use as the heat exchanger.

[CLAIM 6]

The snowmobile four-cycle engine arrangement according to Claim 1 or 2, wherein an integrated configuration comprised of an oil cooler for cooling the engine oil and a radiator for cooling the engine cooling water is put into use as the heat exchanger.

[CLAIM 7]

The snowmobile four-cycle engine arrangement according to Claim 4 or 6, wherein a thermostat is provided in the oil path of the oil cooler.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of the Invention]

The present invention relates to an engine arrangement, and in particular relates to an arrangement of a four-cycle engine mounted on a snowmobile.

[0002]

[Prior Art]

Conventionally, small snow vehicles such as snowmobiles have mainly used two-cycle engines. A two-cycle engine is characterized by a relatively simple engine configuration having the advantages of being lightweight and compact and still providing high power. However, two-cycle engines have drawbacks, when compared with four-cycle engines, of emitting a greater amount of exhaust and louder noise with greater vibrations.

[0003]

The recent worldwide trend demands a silent, clean and environment-conscious engine. Snow vehicle engines are no exception and clean and silent engines have been desired. To deal with this, development of engines for snowmobile into a four-cycle configuration has been studied.

[0004]

A conventional snowmobile 200 typically has a body frame 210 in a monocoque frame configuration as shown in FIG. 5, and an engine 202 is mounted in a space formed between a track housing 211c and a front suspension housing 211b in a front frame (engine mounting frame) 211. For a two-cycle engine, engine 202 is mounted upright in a engine compartment 206.

[0005]

If a four-cycle engine is attempted to be put into use

for a snowmobile in the same manner as above, the upright mounting has been difficult because a four-cycle engine has a greater full height compared to a two cycle engine due to its bulky cylinder head and the necessity of an oil pan. Further, since a four-cycle engine needs additional parts unique to it such as an alternator, supercharger, intercooler, oil filter and the like, it has been very difficult to lay out all these parts in a limited engine compartment space.

[0006]

To deal with this, there has been a layout proposal in that the engine is set inclined forwards in the engine compartment so as to reduce the full height of the engine while the aforementioned components etc., are laid out in the space that is created by the inclined arrangement of the engine.

[0007]

On the other hand, in order to enhance the power of a four-cycle engine which is relatively low in power compared to a two-cycle engine, it is generally known that a supercharger(so-called turbocharger) is provided on the intake side of the engine so as to increase the amounts of air and fuel to be supplied to the combustion chamber, to thereby enhance the engine power.

[0008]

[Problems to be Solved by the Invention]

When the engine has a supercharger, provision of an intercooler in the intake path is effective in improving the intake efficiency. However, when the intercooler is attached, the position at which the intercooler is arranged needs careful thought as to the cooling efficiency of the engine and is affected by the attached position of the supercharger, so that it has been very difficult to design the layout and allot mounting spaces in the engine compartment.

[0009]

For example, when the intercooler is arranged on the top of the engine, the full height of the engine becomes high so that the center of gravity as well as the body height of the snowmobile becomes high, hence the result is not preferable.

On the other hand, when the intercooler is arranged in front of the engine, the heavy part is located away from the center of gravity, so that the maneuverability lowers. Further, there is another drawback in that if the snowmobile is collided, the front part of the engine compartment will be heavily damaged so that damage to the engine will become serious.

[0010]

Moreover, when a four-cycle engine is mounted on a snowmobile and if a V-belt type automatic transmission is used as a transmission, the engine is used at higher speeds

compared to that of a four-wheel vehicle. Therefore, there occurs another problem that the engine oil increases in temperature due to increased amount of heat from the engine, whereby oil film starvation may occur, leading to damage to the engine.

[0011]

The present invention has been devised in view of the above conventional problems, it is therefore an object of the present invention to provide a snowmobile four-cycle engine arrangement with which cooling performance of the air and engine oil supplied to the engine is improved and space saving is achieved without any loss of maneuverability.

[0012]

[Means for Solving the Problems]

The present invention relates to a snowmobile four-cycle engine arrangement, and is characterized in that a snowmobile four-cycle engine has a cylinder head on the top thereof and is arranged in an engine compartment formed in the front body of a snowmobile with its crankshaft laid substantially parallel to the body width and its engine body inclined forwards with respect to the vehicle's direction of travel, and an intake path is arranged on the upper face of the inclined engine body; and a heat exchanger for cooling the engine cooling water, engine oil or air to be supplied to the engine is arranged in a tunnel created inside the body frame for accommodating

a track for driving.

[0013]

Further, it is preferred that the heat exchanger is disposed in front of the track, with respect to the vehicle's direction of travel, inside the tunnel.

It is also preferred that an intercooler for cooling the air to be supplied to the engine is put into use as the heat exchanger.

Moreover, it is preferred that an oil cooler for cooling the engine oil is put into use as the heat exchanger.

It is also preferred that a radiator for cooling the engine cooling water is put into use as the heat exchanger.

It is further preferred that an integrated configuration comprised of an oil cooler for cooling the engine oil and a radiator for cooling the engine cooling water is put into use as the heat exchanger.

It is also preferred that a thermostat is provided in the oil path of the oil cooler.

[0014]

According to the present invention, since the heat exchanger, for snowmobile four-cycle engine, for cooling the engine cooling water, engine oil or air to be supplied to the engine is arranged in the tunnel created inside the body frame for accommodating a track for driving, it is possible to provide a snowmobile four-cycle engine arrangement which

is markedly improved in cooling efficiency by snow powder stirred up during travelling, without being affected by heat from the engine compartment. Further, provision of the heat exchanger outside the engine compartment makes it possible to realize deployment of a four-cycle engine without increasing the full height of the engine. Further, this configuration enhances space saving in the engine compartment and is markedly effective in reducing the body height so avoid any loss of maneuverability.

[0015]

Since the heat exchanger is disposed in front of the track, with respect to the vehicle's direction of travel, in the tunnel, it is possible to arrange it close to, and approximately below, the engine. Therefore, the communication means such as pipes, etc., can be shortened, thus making it possible to simplify the communication paths so reduce the cost.

[0016]

Since the intercooler for cooling the air to be supplied to the engine is put into use as the heat exchanger, it is possible to efficiently cool the air which has been compressed and sent from the supercharger and hence is high in temperature to thereby improve the engine power.

[0017]

Since the oil cooler for cooling the engine oil is put

into use as the heat exchanger, it is possible to efficiently cool the engine oil which is high in temperature. Therefore, it is possible to prevent oil film starvation hence prevent damage to the engine to thereby maintain the engine in a good running state.

[0018]

Since the radiator for cooling the engine cooling water is put into use as the heat exchanger, it is possible to efficiently cool the cooling water which is high in temperature. Therefore, it is possible to prevent the engine from overheating so keep the engine in a good running state.

[0019]

Since the oil cooler for cooling the engine oil and the radiator for cooling the engine cooling water are integrated as the heat exchanger, it is possible to eliminate the necessity of providing an oil cooler and radiator separately hence achieve space saving and reduce the number of parts.

[0020]

Since a thermostat is provided in the oil path of the oil cooler, the engine oil can be kept at a proper temperature. Therefore, it is possible to prevent the engine oil from being excessively cooled, hence keep the engine in a good running state.

[0021]

[Embodiment of the Invention]

Next, the embodiment modes of the present invention will be described in detail with reference to the drawings.

FIG. 1 is a partially sectional side view showing an overall configuration of a snowmobile four-cycle engine of embodiment 1 in accordance with an embodiment mode of the present invention. FIG. 2 is a partially sectional plan view showing an overall configuration of the same snowmobile four-cycle engine.

[0022]

As embodiment 1 a snowmobile four-cycle engine according to one embodiment mode is constructed as shown in FIGS. 1 and 2 so that a four-cycle engine 2 (to be referred to hereinbelow as engine) having a cylinder head 3 at the top thereof is arranged in an engine compartment 6 enclosed by a front cover 4 on the front body side of a snowmobile 1 and inclined forwards with respect to the vehicle' direction of travel with its crankshaft (not shown) laid substantially parallel to the body width and an intake path 5 is arranged on the top of the inclined engine 2 body. In front of the engine body 2 in engine compartment 6 a supercharger (turbocharger) 7 is arranged separately from the engine 2 body while an intercooler 8 for cooling intake air sent from this supercharger 7 to the engine 2 body is arranged at the front side, with respect to the vehicle's direction of travel, inside the tunnel that is formed on the inner side of a body frame 10 in which an aftermentioned drive track belt 15 is accommodated.

[0023]

Now, the configuration of snowmobile 1 will be explained in detail.

Snowmobile 1 has a body frame 10 extending front to rear as shown in FIGS. 1 and 2 with a pair of steerable, ski-type runners 13 arranged on the left and right under the front frame 11, so as to be turned to the left and right. Arranged under the rear frame 12, is a tractive crawler 16 that circulates track belt 15. This crawler 16 comprises a drive wheel 17 arranged at the front end of rear frame 12, an idle wheel 18 arranged at the rear end and a multiple number of middle wheels 19, a suspension mechanism 20 and the track belt 15 wound around these wheels and driven circulatively.

[0024]

Body frame 10 has a monocoque frame configuration. The front frame (engine mount frame) 11 on which engine 2 is mounted is constructed such that the part in front of a main part 11a is projectively formed upward forming a front suspension housing 11b for accommodating the upper part of front suspension 13a for supporting steerable ski-type runners 13. The part in the rear of the main part 11a is constructed such that a track housing 11c for accommodating the upper part of drive wheel 17 of crawler 16 is raised upwards and rearwards and is continuously and integrally formed with rear frame 12.

[0025]

The rear frame 12 is extended from the front to the rear of the vehicle with its interior depressed in the form of a tunnel and also functions as the cover for accommodating the whole track belt 15 under it.

A saddle type seat 22 is arranged on the top of rear frame 12 with steps 23 disposed with respect to body width below on the vehicle's sides of seat 22.

A steering shaft 24 is provided extending upward substantially in the center of the body between the seat 22 and front cover 4 while handlebars 26 extending horizontal to the left and right and slightly inclined rearwards are attached at the top of the steering shaft 24.

Disposed upright in front of handlebars 26 is a windshield 28, from the base of which front cover 4 is formed in a substantially streamline shape, or in a substantially inverted hull-bottom shape gradually lowering to the front.

Steerable ski-like runners 13 are adapted to be steered via steering shaft 24 by the handlebars 26.

[0026]

Next, the configuration of engine 2 will be described in detail.

As shown in FIGS. 1 and 2, the engine 2 is a four-cycle three-cylinder engine having its cylinder head 3 on top and is arranged at the approximate center of engine compartment

6 inside front cover 4 with its crankshaft(not shown) laid substantially parallel to the body width and its cylinder head 3 inclined at a large angle (e.g., more than 45 degrees forwards) in the vehicle's direction of travel.

An intake path 5 including a carburetor, a throttle body etc., is arranged on the upper side of the engine 2 body. An alternator 31 is arranged at the rear of it.

[0027]

A flywheel (not shown) is disposed at one end (on the left side with respect to the vehicle's direction of travel) of the crankshaft and a V-belt type stepless transmission 33 incorporating a centrifugal clutch device is coupled on the outer side of this flywheel. This stepless transmission 33 is configured so as to transmit drive power to track belt 15 via gears etc., on the receiving side. A brake(not shown) is fitted at the other end of the receiving shaft of the stepless transmission 33.

Arranged at the other end of the crankshaft (on the right side with respect to the vehicle's direction of travel) is a pulley 34 functioning as a transmission for driving auxiliary equipment so as to drive alternator 31 and a water pump 35 provided on the pulley 34 side.

[0028]

A starter motor(not shown) is arranged in proximity to the flywheel on the top of the engine 2 body and under intake

path 5 such as carburetor, throttle body etc.

[0029]

Next, the intake system will be described.

The intake system is arranged so that the parts to be disposed on the upper side of engine 2 are positioned inside front cover 4 near the base of windshield 28 where the cover becomes higher while the parts to be disposed in front of cylinder head 3 are accommodated, so as not to interfere with other components, on the front inner side of front cover 4 where it gradually lowers toward the front.

[0030]

Disposed on the top of engine 2 is an intake manifold 37 which branches the intake path 5 from carburetor 36 into the intake ports of the individual cylinders.

A supercharger 7 is arranged in front the engine 2 and an air cleaner 32 is disposed at the frontmost part in engine compartment 6 in front of the supercharger.

An intercooler 8 is arranged in proximity to engine 2 at its rear bottom, but outside engine compartment 6 and on the inner side of body frame 10.

[0031]

One end of supercharger 7 is connected to an intake passage 7a extended forwards so that the supercharger is connected to the air cleaner 32 via this intake air passage 7a.

The other end of the supercharger 7 is connected to

intercooler 8 via an intake air passage 7b which starts from the front side of engine 2 and is bent along the side face of engine 2, in an L-shape as viewed from the top, extended to the rear and bent downwards, in a sectional view, near the engine crankshaft.

An intake air passage 8a is connected to the outlet side of the intercooler 8. This intake air passage 8a extends upwards approximately vertically from the engine 2 bottom and is connected to the carburetor 36 arranged over the engine 2.

[0032]

For air supply to engine 2, air is introduced from the body front via air cleaner 32 into supercharger 7, where the air is compressed and sent. The air which has become high in temperature through supercharger 7 is cooled by intercooler 8 and sent to carburetor 36, from where air is supplied to individual cylinders in engine 2 via intake manifold 37.

[0033]

On the other hand, the exhaust path starts from cylinder case 39 toward the front side of engine 2 and is connected via an exhaust manifold 41 to the inlet side of supercharger 7. The outlet side of the supercharger 7 is connected to an exhaust passage 42, which is extended from the front side of the engine 2 body to the rear along the engine 2 body and connected via the exhaust passage 42 to a muffler 43 arranged

at one side behind the engine.

[0034]

Next, mounting of engine 2 will be described.

As shown in FIG. 1, the engine 2 is inclined forwards in engine compartment 6 and mounted on, and along, front frame 11 with an oil pan 38 arranged adjacent to inclined track housing 11c and cylinder case 39 arranged adjacent to suspension housing 11b.

[0035]

The engine 2 is attached to track housing 11c by oil-pan side brackets 45 and to suspension housing 11b by cylinder-case side brackets 46. Both the oil-pan side brackets 45 and cylinder-case side brackets 46 are angled fittings and arranged left and right on the front and rear sides. Shock absorbers 47 such as cushion rubber are interposed at the fastening sites to front frame 11 so that the engine is supported floatingly on front frame 11.

[0036]

According to embodiment 1 as above, since intake path 5 is arranged on the upper side of engine 2, supercharger 7 and air cleaner 32 are disposed in front of the engine in engine compartment 6 while intercooler 8 is placed outside engine compartment 6 and inside body frame 10, it is possible to realize a compact engine layout and markedly improve the cooling performance of intercooler 8 by eliminating any

thermal effect from engine 2 and by snow powder stirred up during running, to thereby enhance the charging efficiency of intake air.

By arranging the intake path and exhaust path from the front side toward the rear of engine 2 along the body side of engine 2, it is possible to improve the cooling effect on the intake and exhaust paths by air flow during travel.

[0037]

Next, embodiment 2 will be described in detail with reference to the drawings.

FIG. 4 is a partially sectional side view showing an overall configuration of a snowmobile four-cycle engine of embodiment 2. FIG. 5 is a partially sectional side view showing an overall configuration of the snowmobile four-cycle engine. Here, the parts corresponding to those in embodiment 1 are allotted with the same reference numerals without description.

[0038]

A snowmobile four-cycle engine according to embodiment 2 is constructed as shown in FIGS. 3 and 4, so that a four-cycle engine 102 (to be referred to hereinbelow as engine) having a cylinder head 3 at the top thereof is arranged in an engine compartment 6 enclosed by a front cover 4 on the front body side of a snowmobile 100 and the engine 102 body is inclined forwards with respect to the vehicle's direction of travel

with its crankshaft(not shown) laid substantially parallel to the body width and an intake path 5 is arranged on the top of the inclined engine 2 body.

[0039]

An oil cooler 108 is arranged under the engine 102 at the front side, with respect to the vehicle's direction of travel, in the tunnel that is formed on the inner side of a body frame 10. A thermostat valve (not shown) is provided between the inlet and outlet of the oil path of the oil cooler 108.

[0040]

For the intake system configuration, an intake path 5 including a carburetor, a throttle body etc., is arranged on the upper side of the engine 102 body. An alternator 31 is arranged at the rear of it. An air cleaner 32 is arranged in the further rear.

[0041]

According to embodiment 2 as above, since intake path 5 and air cleaner 132 are arranged on the upper side of engine 102, oil cooler 108 is placed outside engine compartment 6 and in the front inner side of body frame 10, it is possible to realize a compact engine layout. Further, since oil cooler 108 is arranged at the front side, with respect to the vehicle's direction of travel, in the tunnel that is formed on the inner side of body frame 10 so that it will not receive any thermal

influence from engine 102 and it is possible to efficiently cool the engine oil which is high in temperature by snow powder stirred up during travel. Therefore, it is possible to prevent oil film starvation and prevent damage to the engine to thereby maintain the engine in a good running state.

Further, since a thermostat is interposed in the oil path of the oil cooler 108, it is possible to prevent the engine oil from being excessively cooled so keep the engine in a good running state.

[0042]

In the above embodiments, intercooler 8 or oil cooler 108 is put into use as a heat exchanger and arranged inside the tunnel-like hollow inside body frame 10. However, the present invention should not be limited to this arrangement. For example, the radiator may be arranged inside body frame 10. In this case, the engine cooling water can be efficiently cooled so that the engine can be prevented from overheating, thus making it possible to keep the engine in a good running state.

[0043]

Further, in the present invention, the oil cooler for cooling the engine oil and the radiator for cooling the engine cooling water may be configured integrally and is put into use as the heat exchanger. In this case, it is possible to provide a space saving arrangement and reduce the number of

parts because of being needless of providing an oil cooler and radiator separately.

[0044]

[Effect of the Invention]

As has been described heretofore, according to the snowmobile four-cycle engine arrangements according to Claims 1 to 7 of the present invention, since a heat exchanger of a snowmobile for cooling the engine cooling water, engine oil or air to be supplied to the engine is disposed inside the tunnel that is formed inside the body frame, instead of arranging it inside the engine compartment, it is possible to achieve space saving inside the engine compartment and reduce the engine height, whereby it is possible to realize deployment of a four-cycle engine, which is environment-conscious.

Further, according to the present invention, it is possible to provide a snowmobile four-cycle engine of which heat exchanger is free from thermal influence from the engine and is markedly improved in cooling performance by snow powder stirred up during running.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[FIG. 1]

FIG. 1 is a partially sectional side view showing an overall configuration of a snowmobile four-cycle engine in

accordance with embodiment 1 of the embodied mode of the present invention.

[FIG. 2]

FIG. 2 is a partially sectional plan view showing an overall configuration of a snowmobile four-cycle engine of embodiment 1.

[FIG. 3]

FIG. 3 is a partially sectional side view showing an overall configuration of a snowmobile four-cycle engine of embodiment 2.

[FIG. 4]

FIG. 4 is a partially sectional plan view showing an overall configuration of a snowmobile four-cycle engine of embodiment 2.

[FIG. 5]

FIG. 5 is an illustrative view showing an overall configuration of a conventional snowmobile four-cycle engine.

[DESCRIPTION OF REFERENCE NUMERALS]

1,100 snowmobile

2,102 engine

5 intake path

6 engine compartment

7 supercharger

8 intercooler

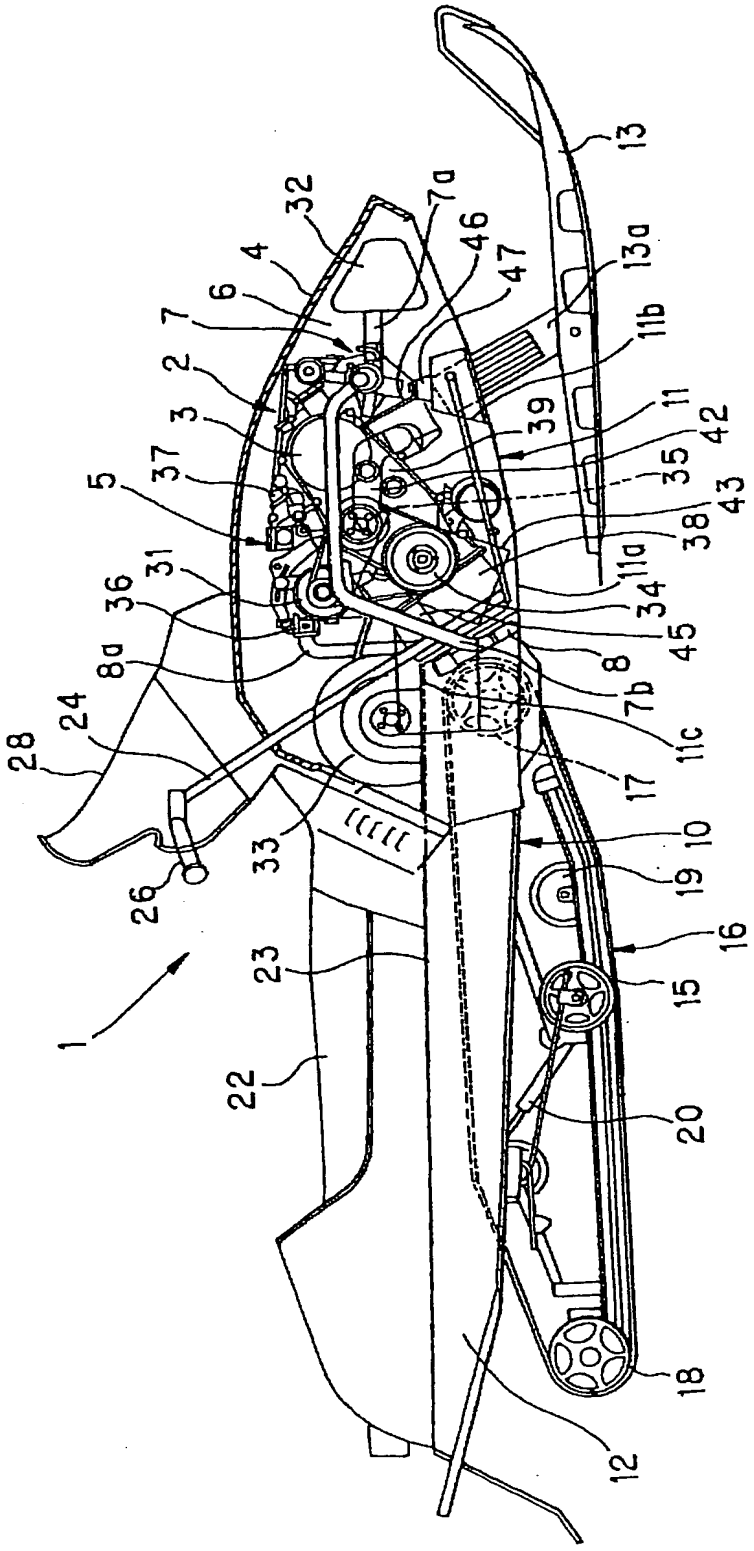
10 body frame

16 crawler

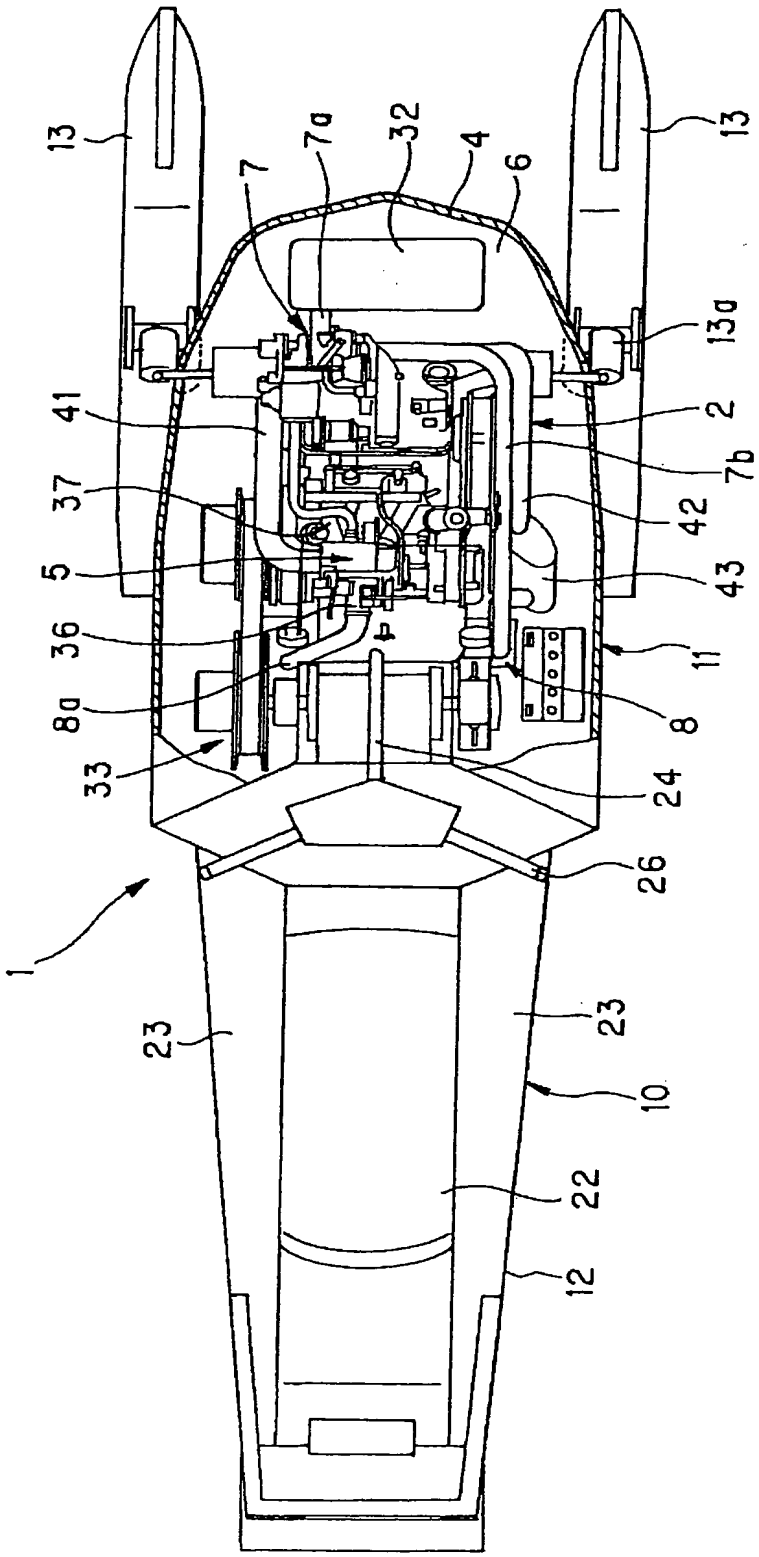
108 oil cooler

[NAME OF DOCUMENT] DRAWINGS

[FIG. 1]



[FIG. 2]


13
7
7a
32
4
6
13
13a
41
2
7b
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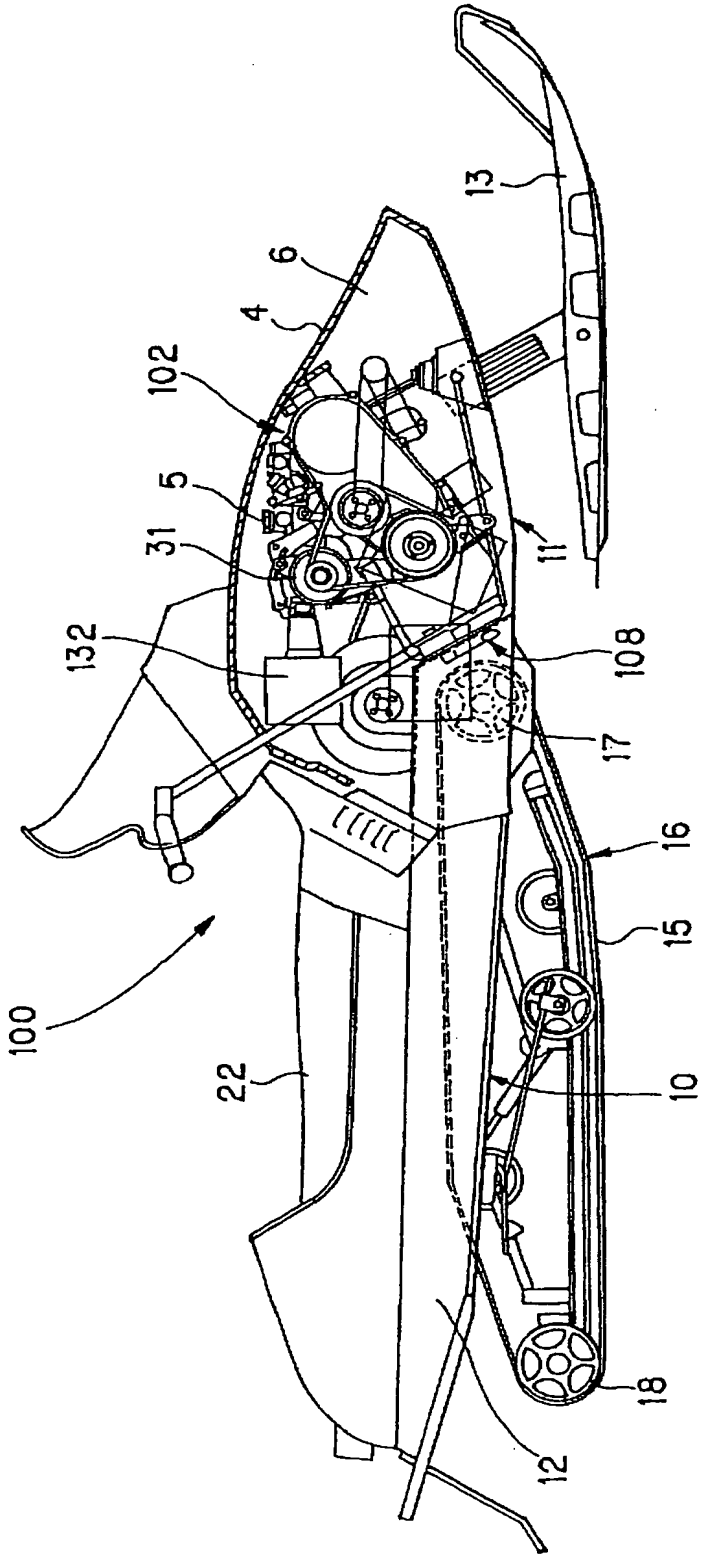
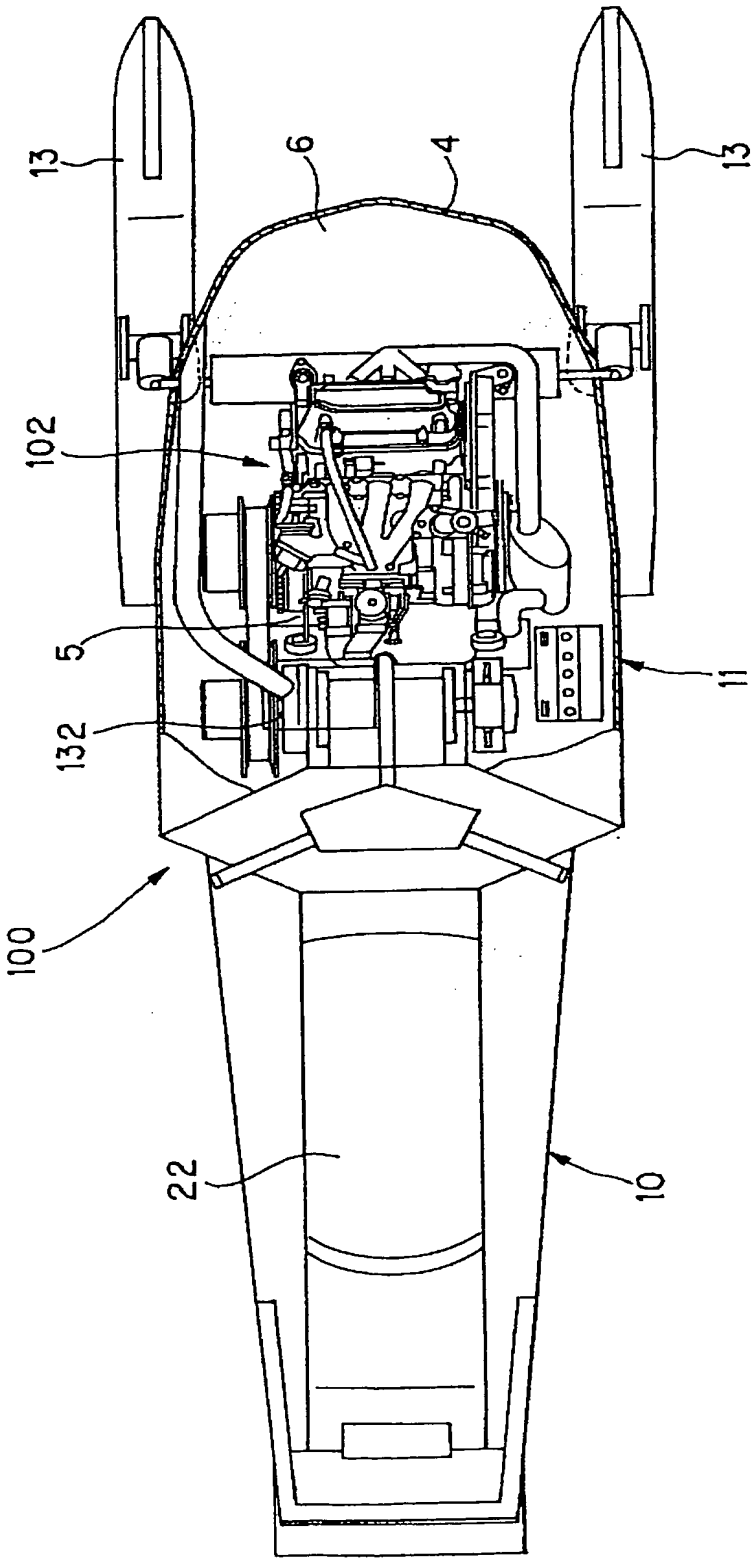
22
12

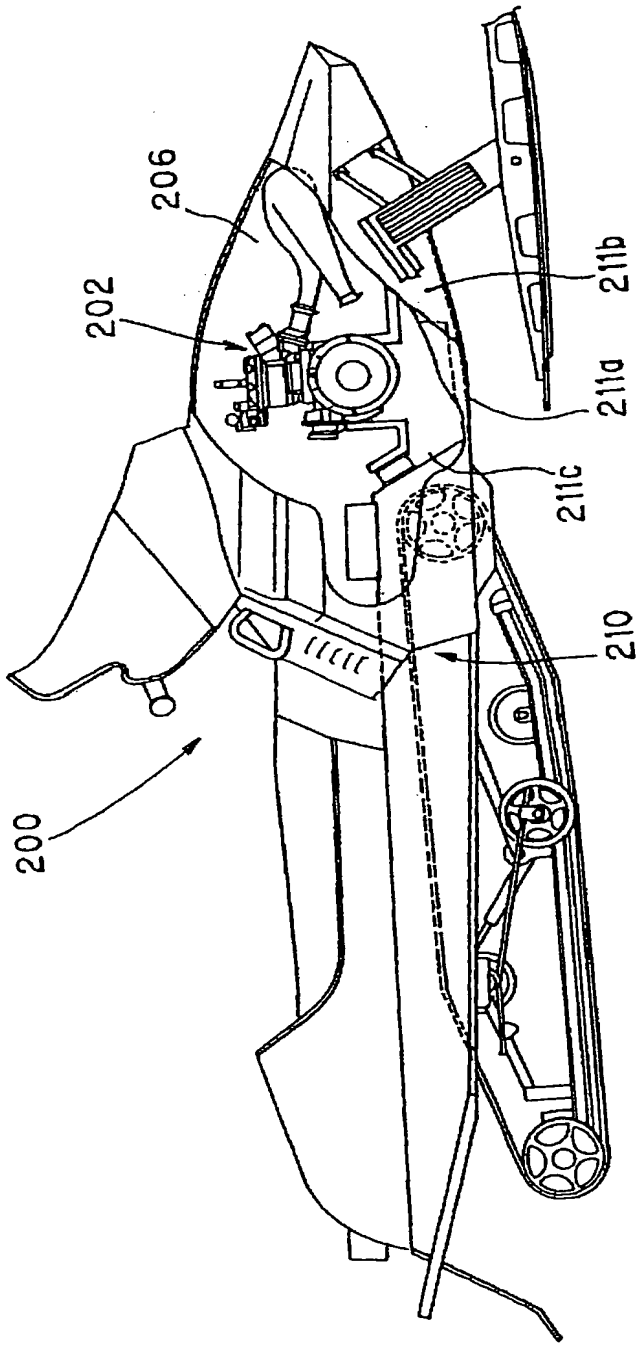
[FIG. 3]



[FIG. 4]



[FIG. 5]



[NAME OF DOCUMENT] ABSTRACT

[ABSTRACT]

[OBJECT]

The object is to provide a snowmobile four-cycle engine arrangement with which cooling performance of the air and engine oil supplied to the engine is improved and space saving is achieved without any loss of maneuverability.

[MEANS FOR SOLUTION]

A snowmobile four-cycle engine arrangement is constructed such that a snowmobile four-cycle engine has a cylinder head 3 on the top of an engine 2 and is arranged in an engine compartment 6 formed in the front body of a snowmobile 1 with its crankshaft laid substantially parallel to the body width and the engine 2 body inclined forwards with respect to the vehicle's direction of travel, and an intake path 5 is arranged on the upper face of the inclined engine 2 body; and an intercooler 8 for cooling the intake air is arranged in a tunnel that is formed on the inner side of a body frame 10 for accommodating a track belt 15.

[SELECTED DRAWING] FIG.1

Information of Applicant Data

Identification No. [000002082]

1. Change Date April 27, 1991

[Reason of Change] Change of address

Residence 300, Takatsuka-cho, Hamamatsu-shi, Shizuoka-ken

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